8th Asia-Pacific Conference on Plasma Physics, 3-8 Nov, 2024 at Malacca

The Two-Banded Structure of Ion-scale Waves in the Solar Wind: Linear and Quasilinear Kinetic Theories

Jungjoon Seough[1], Sung Jun Noh[2], and Peter H. Yoon[3]
[1] Korea Astronomy and Space Science Institute, South Korea,
[2] Los Alamos Laboratory, USA, [3] IPST, University of Maryland, College Park, USA
e-mail (speaker): seough@kasi.re.kr

The electromagnetic waves at ion scales have been often observed in the inner heliosphere. According to statistical analysis of the Parker Solar Probe (PSP) measurements, the majority of ion-scale waves, propagating preferentially quasi-parallel to the ambient magnetic field, in the solar wind frame, directs away from the Sun [1,2]. It is expected that those waves are locally driven by the ion kinetic instabilities, which arise from the non-thermal properties of solar wind ions, including temperature anisotropy and different flow speed between ion species.

A recent study reports the PSP observation associated with the ion-scale wave events that exhibit the two distinct wave packets with opposite polarization at different frequencies [3]. With the aid of the linear dispersion analysis under consideration of the Doppler-shift effect, it turns out that the perpendicular temperature anisotropy of proton core as well as the field-aligned proton beam are likely to be the primary sources of free energy responsible for the generation of such wave packets.

In this study, the linear Vlasov analysis of both the proton cyclotron and the proton beam instabilities is carried out to investigate the favorable conditions for the excitation of the two-banded structure of ion-scale waves. We further present the quasilinear theory of those instabilities and discuss the importance of the bi-directionally propagating waves as well.

References

[1] Bowen et al., ApJS, **246**, 66 (2020a).
[2] Bowen et al., ApJ, **899**, 74 (2020b).
[3] Noh et al., in preparation (2024).